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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/502,729	02/11/2000	Stephan Alan Cohen	YO999-573	5596

7590 05/06/2002

Rocco S Barrese Esq
Dilworth & Barrese
333 Earle Ovington Boulevard
Uniondale, NY 11553

EXAMINER

LOUIE, WAI SING

ART UNIT PAPER NUMBER

2814

DATE MAILED: 05/06/2002

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/502,729

Applicant(s)

COHEN ET AL.

Examiner

Wai-Sing Louie

Art Unit

2814

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 28 January 2002.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-16 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-16 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____.
- 4) ☐ Interview Summary (PTO-413) Paper No(s). _____.
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: _____.

DETAILED ACTION

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

Claims 1-6 and 8-10 are rejected under 35 U.S.C. 103(a) as being unpatentable over Li et al. (US 2002/0020919) in view of Park (US 6,100,559).

With regard to claim 1, Li et al. disclose a diffusion barrier layer ([0020] to [0029] and fig. 2) for semiconductor devices having an upper surface and a lower surface and a central portion and comprising silicon, carbon, nitrogen, and hydrogen ([0024]). Li et al. teach the conductive material 32 should be surrounded by nitride to prevent diffusion of Cu into insulative material 40 and oxygen into Cu layer 32 ([0012] and fig. 2), but Li et al. do not disclose the nitrogen being non-uniformly distributed throughout the diffusion barrier layer 100. However, Park discloses a graded silicon oxynitride layer 36, which has a nitrogen rich at the surface and non-nitrogen rich away from the surface (Park col. 5, lines 28-35). Park teaches the nitrogen rich region is for interface/mechanical strength and the non-nitrogen rich region serves as an antireflective coating, ARC (Park col. 5, lines 35-38). Therefore, it would have been obvious to one with ordinary skill in the art to include a non-uniformly distributed barrier layer in Li's device in order to have the mechanical strength to prevent the Cu diffusion and also acts as an ARC layer.

With regard to claims 2-4 and 8-10, Li et al. do not disclose the nitrogen is more concentrated near the upper and lower surfaces than the central portion of the diffusion barrier layer 100 compared to the central portion. However, Li et al. teach the conductive material, Cu is generally surrounded by nitride material to prevent diffusion of Cu into insulative material or others into Cu material ([0012]). Therefore, it is obvious that the upper and lower surfaces of the diffusion barrier layer 100 must contain more nitrogen than the central portion of the diffusion barrier layer to prevent the diffusion of Cu into the insulative material or insulation material into the Cu layer.

With regard to claim 5, Li et al. do not disclose the barrier layer 100 comprising oxygen. However, Park discloses the graded silicon oxynitride layer 36 in claim 1 serves a multiple functions, i.e., a barrier layer, an etch-stop layer, and an ARC layer. Therefore, it is obvious to substitute the N in $(\text{CH}_3)_x\text{Si}_3\text{N}_{4-x}$ with ON.

With regard to claim 6, Li et al. do not disclose the carbon and silicon in the layer is in the form of silicon carbide. However, in the CVD process, the carbon and silicon, inherently, could form silicon carbide.

Claims 7 and 11-16 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ngo et al. (US 6,228,761) in view of Li et al. (US 2002/0020919) and Park (US 6,100,559).

With regard to claim 7, Ngo et al. disclose a semiconductor device (col. 4, line 35 to col. 6, line 48 and fig. 10) comprising:

- A substrate 40 containing conductive elements;

- A diffusion barrier layer 56 applied to at least a portion of the substrate in contact with the conductive metal 58. Ngo et al. do not disclose the diffusion barrier layer 56 having an upper and a lower surfaces and a central portion comprising silicon, carbon, nitrogen, and hydrogen with nitrogen being non-uniformly distributed throughout the diffusion barrier layer 56. However, Li et al. modified by Park, in claim 1 above, disclose the above-mentioned layer. Li et al. teach the silicon chemically bonded oxynitride and organic material would provide a barrier between the conductive metal and insulative material to prevent the diffusion of elements (Li [0021] and [0025]). Therefore, it would have been obvious to one with ordinary skill in the art to provide the diffusion barrier layer having an upper and a lower surfaces and a central portion with nitrogen being non-uniformly distributed throughout the layer. Doing so would prevent the diffusion of elements and damage the device.

With regard to claim 11, Ngo et al. modified by Li et al. and Park disclose the nitrogen is distributed only in the upper surface of the diffusion barrier layer (Park fig.5).

With regard to claim 12, Ngo et al. disclose the conductive element is made from tungsten (col. 6, line 29).

With regard to claim 13, Ngo et al. disclose the conductive element is made from tungsten (col. 6, line 29), but do not disclose the conductive elements are made from copper. However, Li et al. disclose copper is used in the conductive layer. Since copper is a common conductive material and is a better conductive material. Therefore, it is obvious that copper could be used in Ngo's device as an design alternative.

With regard to claims 14-15, Ngo et al. do not disclose the thickness of the diffusion barrier layer 56 or other layers. Since the applicant has not established the criticality of [the thickness or concentrations] stated and since these [the thickness or concentrations] are in common use in similar devices in the art, it would have been obvious to one of ordinary skill in the art to use these value in the device of [the thickness or concentrations]. Where patentability is said to be based upon particular chosen dimension or upon another variable recited in a claim, the applicant must show that the chosen dimensions are critical. In re Woodruff, 919 F2d 1575, 1578, 16 USPQ2d 1934, 1936 (Fed. Cir. 1990).

With regard to claim 16, Ngo et al. do not disclose a portion of carbon and silicon is in form of silicon carbide. However, Li et al. disclose in claim 6 above that silicon carbide could be formed.

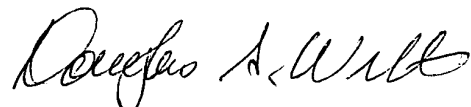
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Any inquiry concerning this communication or earlier communications from the examiner should be directed to Wai-Sing Louie whose telephone number is (703) 305-0474. The examiner can normally be reached on 7:30 AM to 4:00 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Olik Chaudhuri can be reached on (703) 306-2794. The fax phone numbers for the organization where this application or proceeding is assigned are (703) 308-7722 for regular communications and (703) 308-7722 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308-0956.



Douglas A. Wille
Patent Examiner



wsl
April 5, 2002